DOCUMENT RESUME

ED 292 339 FL 017 256

AUTHOR	Palma, Elvina L.; Myer, Bettye J.
TITLE	Language Learning through Science Activities: Grade School (F.L.A.G.) and Immersion Settings.
PUB DATE	88
NOTE	12p.; In: Lalande, John F. II, Ed., Shaping the Future of Language Education: FLES, Articulation, and Proficiency. Report of Central States Conference on the Teaching of Foreign Language; see FL 017 249.
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052) -- Reports - Evaluative/Feasibility (142) -- Speeches/Conference Papers (150)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Class Activities; Classroom Techniques; *Curriculum Development; Elementary Education; *FLES; *Immersion Programs; Lesson Plans; *Science Activities; Science Instruction; Second Language Instruction; *Second Language Learning; *Second Language Programs; Vocabulary Development
IDENTIFIERS	Content Area Teaching

ABSTRACT

A discussion of the use of science activities as a technique for second language instruction focuses on its application in both immersion and more traditional pull-out programs in the elementary school. First, a rationale for the use of hands-on science experiences in grade school second language classes is presented, noting the value of the emphasis on content and evidence in the literature supporting the use of science activities for language development. Second, a four-step procedure for the introduction of vocabulary and structures that leads the learner carefully through the stages of listening comprehension to speech production is presented and illustrated in a lesson plan. Brief descriptions of viable options for science lessons and a list of print resources are also included. (MSE)

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Language Learning through Science Activities: Grade School (F.L.A.G.) and Immersion Settings

Elvina L. Palma
Kenwood French Immersion School, Columbus, Ohio
Bettye J. Myer
Miami University, Oxford, Ohio

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In an immersion setting or in a more traditional "pull-out" program, the frequent use of science activities in the second language classroom can provide excellent opportunities for the development of second language communication skills.[1] Why are science activities appropriate in the second language classroom? The purpose of this article is to address this question in the context of the elementary school level, to present a four-step procedure that is structured to lead the learner carefully through stages of listening comprehension to speech production, and to suggest a variety of science experiences and resources. First, a *rationale* for hands-on science experiences in grade school second language classes is presented, followed by a *lesson plan* that includes the *four-step procedure* for the introduction of vocabulary and structures, brief descriptions of viable *options for science lessons*, and a listing of *resources*.

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An Emphasis on Content

To teach content through a second language may be the most efficient approach to the teaching/learning of a second language for all children. The development of a second language curriculum that integrates content from subject areas taught in the elementary school, e.g., to teach food groups and the process of selecting a well-balanced diet, as well as the names of food items is encouraged (Myer and Palma, 6; Benya and Myer, 1; Woodruff, Benya, Myer, and Palma, 11; Woodruff, Benya, Berry, Evans, and Myer, 10). For an immersion orientation, Curtain (3) has also advocated an integrated approach, not only for the immersion setting but for FLES classes as well. A strength of the immersion setting, teaching content through the language, is central to the F.L.A.G. (Foreign Language Arts in the Grades) approach. Attention to content, in addition to language, quite naturally allows a teacher to consider the process of learning specific content.

A key to the development of language proficiency is the relationship of language use to the real world of the learner. Consider an ideal learning situation for a second language. The following characteristics might be included.:

1. Content of great interest to the learners
2. Multisensory involvement
3. Highly structured initial presentations
4. Vocabulary presented in thematic clusters
5. A process of learning that includes many repetitions: variations on a theme
6. Pupil-pupil interaction
7. An approach that encourages problem solving
8. A classroom environment simulating real-world situations where authentic communication is needed

A rich source of content to create such an optimum learning environment is one that is frequently overlooked in the grade school classroom: the realm of science. Not only is science everywhere (e.g., in music, health and nutrition, sports, metric measurement and so on) but the processes inherent in the scientific approach—e.g., hypothesizing, predicting, observing, describing, inferring, classifying, concluding,

exploring—encourage curiosity, creative thinking, problem-solving, persistence, and the communication of ideas relevant to the child's world. An examination of stated rationales for science programs reveals that many of the traits of an ideal setting to learn a second language are provided for in hands-on science programs. Hands-on activities have these effects and qualities:

1. Develop process skills
2. Reduce learner anxiety
3. Benefit children of different ages, abilities, learning styles, and achievement levels
4. Require learner participation
5. Stimulate curiosity and inquiry
6. Generate content-relevant speech
7. Develop a positive learner self-concept

Science and Language Development

Evidence in the science education literature relates the development of language skills, especially for disadvantaged learners, to hands-on science programs. "It is far more powerful and long lasting to build vocabulary in the context of direct experience than through the introduction of vocabulary lists" (Rowe, 8, p. 77). In a review of research that discusses the development of young children's communication skills during science activities, Wellman (9) summarizes eighteen studies that relate manipulative science experiences to success in beginning language and reading achievement (kindergarten to grade 6). Huff and Languis (4) found that for disadvantaged kindergarten children hands-on science activities provided in *Science—A Process Approach* (SAPA) were positively correlated with the development of oral communication skills. Wellman (9) cites Horn and Stemmler who studied the oral language development of culturally deprived Spanish-speaking children in grade 1. They concluded that the participation and concrete manipulation provided by the activities in the SAPA materials resulted in gains in the number of complete spoken sentences,

length of attention span, auditory discrimination, listening, and ability to follow directions.

Children in grades 4, 5, and 6 demonstrated increases in verbal fluency, ability to form concepts, logical thinking, and communication skills (Wellman, 9; Mechling and Oliver, 5). The research results indicate a positive relationship between activity-centered science programs and the development of oral language skills and reading readiness. To include science experiences among the hands-on activities in the second language classroom provides opportunities for developing learner process skills in a context that can be highly motivating.

Lesson Plan: Four Steps

The following lesson plan is an example of a physical science lesson that incorporates pitch perception. It lends itself to several subsequent lessons, including playing music on glasses of water. The Four Steps (Woodruff, Benya, Myer, and Palma, 11) used in this lesson provide a procedure for introducing most basic structures and vocabulary.[2] In this illustration, the procedure also teaches the content of the lesson.

Lesson Plan: Concerto in a Glass

Source of Content: *Je me petit-débrouille* (Maltais, F.)
Behavioral Objective: In French, the students will be able to predict the relationship between pitch and water level when given examples of glasses filled to different levels.
Prerequisite Knowledge: *plus* + adjectif
New Active Vocabulary: *grave, plus grave, la même aigu(e), plus aigu(e)*
Supplementary Vocabulary: *la hauteur, le niveau de l'eau*
Materials Needed: six glasses, one spoon, water, a sink or basin, newspapers, or paper towel to cover the table
Four Steps:

1. **Presentation for identification**
   Teacher illustrates the difference between expressions to describe low- and high-pitched, lower- and higher-pitched, the same.
   La hauteur du son est grave.

The pitch is low.

(Teacher taps a full glass of water.)

La hauteur du son est aigue.

The pitch is high. (an empty glass)

La hauteur du son est la même.

The pitch is the same. (another empty glass)

La hauteur du son est plus grave.

The pitch is lower. (a half-full glass)

La hauteur du son est plus aigue.

The pitch is higher. (a quarter-full glass)

2. **Practice in identification**

Répondez "oui" ou "non":

Est-ce que la hauteur du son est grave?

(a full glass)

"Oui."

Est-ce que la hauteur du son est aigue?

(an empty glass)

"Oui."

Est-ce que la hauteur du son est la même?

(another empty glass)

"Oui."

Est-ce que la hauteur du son est la même?

(a fuller glass)

"Non."

Est-ce que la hauteur du son est plus aigue?

(an emptier glass)

"Oui."

Est-ce que la hauteur du son est plus grave?

(a fuller glass)

"Non."

3. **Practice in imitation**

Répétez après moi.

Est-ce que la hauteur du son est grave?

(a full glass)

La hauteur du son est grave.

(Students repeat all expressions after the teacher as the pitch is illustrated.)

4. **Practice in communication**
   a. Questions answered by "yes"
   (Teacher taps a glass to elicit "yes" answer.)
   Est-ce que la hauteur du son est grave?
   (a full glass)
   Oui, la hauteur du son est grave.
   Est-ce que la hauteur du son est aigue?
   (an empty glass)
   La hauteur du son est aigue.
   ("Yes" answers are required for all expressions.)
   b. Choice questions
   (Teacher taps a glass and provides the answer in the choices modeled.)
   Est-ce que la hauteur du son est grave ou aigue?
   (a full glass)
   La hauteur du son est grave.
   (All expressions are presented.)
   c. Questions answered by "no"
   (Teacher contradicts what is illustrated, requiring "no" plus a correct affirmative answer.)
   Est-ce que la hauteur du son est grave?
   (an empty glass)
   Non, la hauteur du son est aigue.
   (All expressions are questioned.)
   d. Information questions
   Quelle est la hauteur du son?
   La hauteur est grave.
   (All expressions are questioned.)

Follow-up Lesson: Water Glass Concerto

Content: Tapping a set of glasses to produce a song
Objective: The student will be able to play a song on glasses filled to various levels that when struck with a pencil produce musical tones.
Procedure: Prepare the glasses filled to allow the playing of a musical sequence (the portion of the scale needed for the song chosen). Play the song through; then ask the children to try, using a "play-by-number"

guide. (Suggestion: "It's a Small World", i.e., *Notre monde est bien petit*). (Source: Elvina L. Palma, Kenwood French Immersion School, Columbus, Ohio)

Follow-up Lesson: A Salty Concerto

Content: Tapping a glass of water before and after salt has been added to it to determine pitch change

Objective: The student will be able to predict the outcome (how or if pitch will rise, fall, or stay the same when the glass is tapped) of adding salt to a glass of water.

Procedure: Select two glasses that produce the same tone when struck by a nonmetal instrument. Measure the same amount of water to fill each about halfway. Demonstrate the sound of the glass half-filled with water. Ask the children if they think the pitch will rise, fall, or stay the same if salt is added to the water. Write "yes," "no," and "the same" (*oui, non, ne change pas*) on the board. Count the number of children who predict the three different outcomes, tabulating numbers under each category. Add salt to one glass until there is a noticeable drop in pitch (one-half cup or more). Stir. Compare the pitches of the two glasses. Check the student predictions. (Source: *Je me petit-débrouille*, Maltais, F.)

Selected Science Activities

1. Dance of the Molecules
   Suggested fast music: "The Magic Fire Music" from *The Valkyries* by Wagner
   Suggested slow music: "Tales from the Vienna Woods" by Strauss
   Children pretend to be molecules and react according to the characteristics of molecules when affected by heat or cold. Prepare 5″ × 8″ index cards with H_2O written on them, tied with yarn to go around each child's neck. Show a picture of ice when the slow music is played. The children move very sluggishly to depict the contraction of the molecules. Show a picture of fire when the fast music is played. The children move quickly, demanding more space and depicting the expansion of molecules.

This is an introduction to the characteristics of molecular behavior. Language production: *j'ai froid* (I'm cold); *j'ai chaud* (I'm hot); *je suis fatigué(e)* (I'm tired); *j'ai envie de danser* (I feel like dancing); *je n'ai pas envie de danser* (I don't feel like dancing); *vite* (fast); *plus vite* (faster); *très vite* (very fast). (Source: Harvey Hallenberg, Berry Day School, Maryland)

2. Temperature Chart I (Unit Lesson)
   This is an activity that will help children become aware of the temperature differences at various heights in their classroom. A six-foot 2 × 4 beam on a stand is set at a convenient place in the classroom. Six thermometers are attached equidistant from one another along the length of the beam, i.e., the lowest being placed nearest the floor on the beam, the highest at the top. The thermometers may be cradled in cardboard tubes found in paper towel rolls. The are more easily attached to the beam this way. Children will check the temperatures three times daily—morning, noon, and afternoon—and record findings on a chart. They should do this for a week. This is an excellent way of demonstrating the principle of rising hot air. Language production: *la température* (temperature); *les degrés* (degrees); *le matin* (morning); *midi* (noon); *l'après-midi* (afternoon); *le plus bas* (the lowest); *le plus haut* (the highest); *le plus chaud* (the hottest); *le plus froid* (the coldest); *le centre* (center); *le thermomètre* (thermometer); *le plancher* (floor); *le plafond* (ceiling); *près de* (close to); *loin de* (far from); *Quelle est la température?* (What is the temperature?); *à cause de* (because of); *l'air chaud* (hot air); *l'air froid* (cold air); *monte* (rises); *descend* (falls). (Source: Roger Pelland, Roslyn French Immersion School, Montreal, Quebec)
3. Blueprint Photography (Unit Lesson)
   This experiment is used to illustrate the reaction between sunlight and blueprint paper and between blueprint paper and ammonia. Leaves and flowers may be collected as part of a lesson on activities of green plant life. Tape a 10″ × 12″ piece of plexiglass to a piece of heavy cardboard the same size, putting masking

tape along one side so as to form a book. Place a piece of diazotype blueprint paper (available from architect suppliers or blueprinting companies) between the plexiglass and cardboard. Position the plant cuttings on the paper to form an arrangement. Close the plexiglass and cardboard holder. Hold to sun for five to seven seconds or in front of a filmstrip projector light (this will take several minutes). The light will react with the diazo salts on the paper, and it becomes bleached out wherever the light hits. Remove plants. The shadow of the plant will remain on the paper. Place the paper in a closed container with a sponge soaked in ammonia. A wide and deep Tupperware container works well. Caution should be taken because of the ammonia fumes. The paper should remain in container until the shadowed areas have turned blue, black, or sepia, depending on the paper. The result is a "photograph" created by the student. Language production: *une feuille, des feuilles* (leaf, leaves); *une herbe mauvaise, des herbes mauvaises* (weed, weeds); *une plante, des plantes* (plant, plants); *une brindille, des brindilles* (twig, twigs); *la lumière du soleil* (sunlight); *la lumière du projecteur* (projector light); *réagit sur* (reacts with); *mets, mettez* (put, place, singular and plural command forms); *ouvres, ouvrez* (open, singular and plural command forms); *ferme, fermez* (close, singular and plural command forms); *à cause de* (because of); *une photographie* (a photograph); *en bleu, en brun, en noir* (in blue, brown, black); *l'ammoniac* (ammonia); *les vapeurs de l'ammoniac* (ammonia vapors). (Source: Marlin Languis, Ohio State University, Columbus, Ohio)

Conclusion

The rationale for the use of hands-on science activities in the second language classroom is convincing. For many second language teachers the realm of science is territory yet to be explored. It is not uncharted territory, however, because excellent materials and procedures have been developed by science educators, in accordance with the developmental stages of grade school children.

To capitalize on the strengths of science activities may require risk

taking on the part of many second language teachers. But the willingness to take risks is one of the strengths of those who have learned and teach a second language. Risk taking is familiar ground.

Resources

The following resources may be useful in the selection and creation of science activities for developing second language lessons:

Science Magazines for Children (French)

Gregoire, J. *Zip*. Beauceville, Quebec: Interglobe, 1987.
Maltais, F. *Je me petit-débrouille* Quebec: Loisirs Quebec, 1987.
Oriol, A. *Mikado*, Belgique: Editions Soumaillon, 1987.

Teachers' Favorites

Ranger Rick's NatureScope Series. Washington, DC: National Wildlife Federation, 1987.
Marcuccio, Phyllis. R. *Science and Children*. National Science Teachers Association. Harrisburg, PA: McFarland Company, 1987.

Teacher Ideas

Allen, Dorothea. *Elementary Science Activities for Every Month of the School Year*. New York: Parker Publishing, 1981.
Allison, Linda. *Blood and Guts: A Working Guide to Your Own Insides*. Boston: Little, Brown, 1976. (Grades 5 and 6)
Brown, Sam, ed. *Bubbles, Rainbows, and Worms: Science Experiments for Preschool Children*. Mt. Rainier, MD: Gryphon House, Inc., 1981.
Cramer, Jerome, ed. "Hands-on, Minds-on Science, Are You Ready to Teach It?" (Special Issue). *Instructor*, Spring 1987.
DeBruin, Jerry. *Creative Hands-on Science Experiences Using Free and Inexpensive Materials*. Carthage, IL: Good Apple, Inc., 1987.
DeVito, Alfred, and Gerald H. Krockover. *Creative Sciencing, Ideas and Activities for Teachers and Children*. Boston, MA: Little, Brown, 1980.
Mebane, Robert C., and Thomas R. Rybolt. *Adventures with Atoms and Molecules: Chemistry Experiments for Young People*. Hillside, NJ: Enslow, 1985.

Textbooks

Mallinson, George G., Jacqueline B. Mallinson, William L. Smallwood, and Catherine Valentino. *Silver Burdett Science*. Morristown, NJ: Silver Burdett, 1987.
Voltmer, Rita K. *Earth Science*. Morristown, NJ: Silver Burdett, 1987.

Supplier Information

Marcuccio, Phyllis R., and Marcia Reecer, eds. *Science and Children* 24, 4 (1987). (Information on textbooks, computer software, and so on, for the science classroom.)

Notes

1. The authors wish to acknowledge Roger Cunningham and Marlin Languis, whose elementary school science classes at Ohio State University, Columbus, Ohio, provided instruction and guidance in exciting new curriculum areas in the foreign language classroom.
2. The procedure referred to as *Four Steps* was developed by Melba Woodruff (emeritus professor, Ohio State University) during her years of teaching in the university laboratory school. This same procedure can be used for the introduction of most grammar and vocabulary, for listening and reading. Only the last phase of the production step (Step 4d) varies, according to the nature of the statement. For noun forms, Step 4d, would be "What is it?" (*Qu'est-ce que c'est?*). For verbs, an example would be "What is he/she doing? (*Qu'est-ce qu'il/elle fait?*)

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3. Curtain, Helena Anderson. "Integrating Language and Content Instruction," *ERIC/CLL News Bulletin*, 9, 2 (1986): 1, 10.
4. Huff, Phyllis, and Marlin Languis. "The Effects of the Use of Activities of SAPA of the Oral Communication Skills of Disadvantaged Kindergarten Children." *Journal of Research in Science Teaching* 10 (1973): 165–173.
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11. _____, Rosemarie Benya, Bettye J. Myer, and Elvina L. Palma. "Foreign Language Arts in the Grades (F.L.A.G.)." In progress.